Collaborative Research on Resilient Infrastructure and Sustainability Education:
Addressing the Challenges faced by STEM Students following Hurricane Maria in Puerto Rico

Panelists: Carla López del Puerto, O. Marcelo Suárez, Humberto Cavallín and Canny Bellido

Hurricane Maria made landfall on September 20, 2017, near Yabucoa, Puerto Rico causing major damage to the island’s infrastructure. In the aftermath of the storm, Puerto Ricans had limited access to clean water, electrical power, communications, and basic healthcare services. The devastation led to over 3,000 deaths and increased awareness regarding the disproportionally large impact of natural disasters on vulnerable populations, such as university students.

This panel will present four NSF-funded projects sharing the common goal of providing support to STEM students to ensure that they succeed despite the challenges imposed by the aftermath of a natural disaster.

- The CREST Phase II Nanotechnology Center for Biomedical, Environmental and Sustainability Applications\(^1\) showed its true commitment to outreach by helping out the communities served through the Center’s strategic network of Materials Science & Engineering clubs hosted by public intermediate and high schools. In the wake of the storm, CREST staff, professors, and students sometimes with the assistance of the US National Guard tended to those communities to provide assistance to families in dire needs. Students supported by the Center continued to excel in their research despite the challenging conditions. This is evidenced by the research awards and recognitions that students received in professional conferences just weeks and months after the hurricane.

- The Ecosystem to Expand Capabilities and Opportunities for STEM Undergraduates\(^2\) (EECOS) was designed following Hurricane Maria to provide students with (1) financial support, (2) academic support, and (3) socio-emotional support to increase retention and graduation. In addition, the project team will generate important knowledge about student resilience and persistence after a natural disaster, the importance of an ecosystem of support that includes academic and socio-emotional support systems, and the validity of the adage that financial aid alone cannot increase student success.

- The Program for Engineering Access, Retention, and LIATS Success\(^3\) (PEARLS) addresses college access and economic hardships of Low-Income Academically Talented Students (LIATS). The project provides financial and academic support and investigates the effectiveness of an institutional intervention model seeking to increase the retention and academic success of talented engineering students coming from economically disadvantaged families.

- The Resilient Infrastructure and Sustainability Education – Undergraduate Program\(^4\) (RISE-UP) was designed in the aftermath of Hurricane Maria in response to the need to train future professionals to design and build infrastructure that can withstand the impact of natural events. After the natural disaster, it became evident that multiple disciplines need to come together to rebuild the damaged infrastructure using new paradigms. The project is a collaboration among three University of Puerto Rico campuses. It includes a novel interdisciplinary curricular sequence that emphasizes the development of research skills (experiential learning) and case study research and turns them into hands-on solutions for real problems/projects.

---

\(^1\) NSF #1345156; \(^2\) NSF S-STEM # 1833989; \(^3\) NSF S-STEM #1833869; \(^4\)NSF HSI # 1832468, 1832427
This session will provide a brief overview of the four NSF-funded projects highlighted above. A discussion with questions from the audience will follow addressing blooming collaborative efforts and synergy among the projects to broaden the social impact of these NSF-funded endeavors. Finally, the session will wrap-up with a summary that would serve the Foundation to become more effective in funding high impact STEM research where underrepresented minorities are involved.

**Panelists**

Prof. Carla López del Puerto is an associate professor in the Department of Civil Engineering and Surveying at the University of Puerto Rico, Mayagüez (UPRM). She received her B.S. in Architecture from Universidad de las Americas-Puebla, her M.S. in Construction Management from the University of Oklahoma and her Ph.D. in Higher Education Administration from Saint Louis University. Prior to joining UPRM, she was a designer and cost estimator for The Benham Companies, an instructor at Southern Illinois University and an assistant professor at Colorado State University. Her research focuses on design and construction management, education and training. She is currently principal investigator of RISE-UP and senior personnel of ePEARLS.

Prof. Oscar Marcelo Suárez obtained his PhD in Metallurgical Engineering from the University of Wisconsin – Madison and is the coordinator of the graduate program in Materials Science and Engineering at the University of Puerto Rico - Mayagüez (UPRM), the only one in its type in Puerto Rico. He is also the director of the NSF-funded Nanotechnology Center Phase II, a ten-year old effort and the largest investment of the Foundation at UPRM. His areas of research and interests range from aerospace materials and metal additive manufacturing to sustainable building materials as well as public education. He is currently co-principal investigator of RISE-UP and ePEARLS, two NSF initiatives that are the core themes of this panel.

Prof. Humberto Cavallín: Faculty at the School of Architecture, Rio Piedras Campus /UPR. Holds a professional degree in Architecture, a PhD on Design Theory and Methods in Architecture from University of California, Berkeley, and a Master of Science (MSc) in Social Psychology at the Universidad Central de Venezuela. Current research focuses on problem solving in design, and the role of architectural design on the microbiology of the built environment.

Prof. Canny Bellido is a School & Educational Psychologist and a full professor in the University of Puerto Rico at Mayagüez Teacher Preparation Program and the Psychology Department. The Founder and Coordinator of the UPRM Resource Center for Education Research and Services Center (CRUISE), Dr. Bellido has directed or evaluated more than 17 education research, professional development, and outreach projects. She has coordinated the campus Center for Professional Enrichment for ten years. She is a co-principal investigator of the NSF EECOS S-STEM project and the Science State Coordinator for Presidential Awards for Excellence in Mathematics and Science Teaching.
Collaborative Research on Resilient Infrastructure and Sustainability Education: Addressing the Challenges faced by STEM Students following Hurricane Maria in Puerto Rico

Panelists:
Carla López del Puerto, UPR – Mayagüez
Marcelo Suárez, UPR – Mayagüez
Humberto Cavallín, UPR – Rio Piedras
Canny Bellido, UPR – Mayagüez
Agenda

I. Hurricane María
II. Brief project overview
   - CREST
   - EECOS
   - ePEARLS
   - RISE-UP
III. Discussion
IV. Summary
Nanotechnology Center: 10 Years in the Trenches

Oscar Marcelo Suárez

Univ. of Puerto Rico - Mayagüez
Chancellor’s Building

Mayagüez Coast, PR

Northern Coast, PR

NSF Awards Nº 083112 & 1345156
Our Materials Science & Engineering Clubs in public schools: *Foundries of Hope*

- Five intermediate schools
- Ten high schools
- 291 female
- 228 male

The bottom line: Fourteen of those schools serve households from 50% to 98% below the poverty line.
The Annual Club Meeting at the UPRM Coliseum

13 months after Maria

always hosted by Nanito

Nothing can be done without our bravest teachers, real life superheroes
A true commitment to outreach: Helping out the community after the storm

The teacher mentor of the club at Río Cañas Abajo Middle Public School led our team visiting families in dire needs.

Sometimes joining the National Guard, sometimes by ourselves, we visited the hilly, devastated neighborhoods of the Mayagüez Municipality.

Several of our CREST public school clubs are in these neighborhoods.
When the night is darker / Thou shalt shine brighter

Andrés Calle, graduate, Industrial Engineering. Defense Innovation Challenge, Tampa, FL, October 2017 (18 days after the hurricane). Defense Innovation Award.

Yamalis López, undergraduate, Chemical Engineering. National Diversity in STEM Conference, Salt Lake City, UT, October 2017 (one month after the hurricane). Best poster presentation, Engineering category

Mónica Díaz, undergraduate, Chemical Engineering. TMS Annual Conference, Phoenix, AZ, February 2018 (five months after the hurricane). First Prize, Structural Materials Division of TMS.

Julie Ann Colón, undergraduate, Chemical Engineering. TMS Annual Conference, San Antonio, TX, March 2019. First Prize, Light Metals Division of TMS.
Graduation in June 2018 (9 months after the hurricane)

BS in Civil Engineering

MS in Industrial, Civil, and Mechanical Engineering

PhDs in Chemical Engineering

And when the night is darker / Thou shalt shine brighter
The Center’s productivity went through the roof in the reporting period after the storm, i.e., from April 2018 through March 2019.

Our Class 100 clean room was not operational for 5 months after the hurricane. During the reporting period, slowly through a technician and a grad student’s relentless work, it became fully operational.

On April 13, 2019, the Center ran interactive demonstrations on nanotechnology at the Mayagüez Mall from 9am – 8pm. The Nanito’s video game was a center piece of the activity.

Our Nanomobile visited Vieques assisting our Material Advantage student chapter’s activity Ceramics in Engineering Showdown on April 26, 2019.

<table>
<thead>
<tr>
<th>Reported product</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Book chapter</td>
<td>1</td>
</tr>
<tr>
<td>Journal or juried conference papers</td>
<td>24</td>
</tr>
<tr>
<td>New website</td>
<td>1</td>
</tr>
<tr>
<td>Other conference presentations</td>
<td>51</td>
</tr>
<tr>
<td>Patents</td>
<td>4</td>
</tr>
<tr>
<td>Master’s theses</td>
<td>4</td>
</tr>
<tr>
<td>Doctoral dissertations</td>
<td>5</td>
</tr>
</tbody>
</table>

... And one educational video game!
Acknowledgment

Hereby, Nanito would like to acknowledge our brave CREST community: grads and undergrads, professors, administrative personnel, teachers and our youngest warriors and their families.

Dr. Andrea Johnson, NSF HSI program officer, meets our CREST students in November 2018 at the GRIC
Ecosystem to Expand Capabilities and Opportunities for STEM Scholars (EECOS)

Dr. Canny Bellido, Co-Pi Socioemotional Support

NSF EECOS STEM # 1833989
Al igual que muchos lo perdí todo, ropa, camas, fotografías de la infancia, etc. Todo sumergido bajo 3 pies de agua y babote. Mientras sacaba mis cosas para llevarlas a un lugar seguro, en el destrozamiento, escuché la voz de mi familia en otro cuarto conversando y en el momento entenderí que nada había perdido. Siempre supe lo que significaba, momentos de espíritu. Con todo este estrés y presión, ¡cómo conseguimos seguir trabajando hasta que al fin pudimos sacar parte del fango!

Como todos sabemos, el semestre después de María fue uno muy irregular y fuerte para nosotros los estudiantes, pues el tiempo fue menor y teníamos mucho material que aprender. En esta etapa, tenía la responsabilidad de viajar constantemente a mi casa en Carolina, para ayudar a mi papá en las reparaciones, ya que carecíamos de fondos, y no teníamos presupuesto para estar pagando mano de obra, por ende, el trabajo lo hemos estado haciendo entre mi papá y yo. Actualmente, mi familia y yo seguimos inmersos todavía en el proceso de recuperación, ya que aún nos quedan áreas por reparar. Seguimos haciendo los recortes necesarios y solicitando las ayudas disponibles, para terminar las reparaciones necesarias y seguir adelante después de tal sufrimiento.

Llegué a P.R. sin nada de dinero debido a los gastos a los que tuve que incurrir. La situación económica y de vivienda infrahumana no había cambiado y ahora tenía que reanudar las clases, lo que implicaba que tenía que llegar al colegio sin contar con transportación, agua y luz. Como respuesta mi promedio se vio afectado ya que de 3.20 bajé a 2.95, fracase en clases y perdí mi beca estudiantil por lo que tuve que solicitar una apelación que resulto afirmativa. Actualmente sigo enfrentando problemas económicos y de salud emocional. Cualquier ayuda es agradecida.
Goal 1: To provide 26 academically talented, low-income, undergraduate UPRM STEM students that have been severely impacted by Hurricane María, with the financial, academic, and socio-emotional support they need to expand their personal and professional capabilities necessary to successfully enter the STEM workforce, and to complete their program within institutionally established time limits (retention and student success).

Goal 2: To adapt and implement an ecosystem of proven financial, academic, and socio-emotional support strategies, and to study the effect of that ecosystem on persistence and student success among academically talented, low income undergraduate UPRM STEM students.

Goal 3: To contribute to the implementation and sustainability of effective evidence-based co-curricular activities for low-income academically talented undergraduate UPRM STEM students severely impacted by Hurricane María, who are pursuing undergraduate education with the intent to pursue graduate education, and entry into the STEM workforce.
Broader Impact

Materials used and lessons learned will be communicated to the broader university academic community nation-wide, in order to provide a framework for support of students after crisis events.

EECOS Intelectual Merit

• Although the principal proposed interventions, including academic mentoring and socio-emotional support with growth mindset modules are proven elsewhere, this is the first time they will be targeted at a population distressed by a disaster event.

• Produce a baseline characterization of the strength of each component within the ecosystem that will increase student retention and promote student success.

• These components may serve as useful tools for faster and more effective responses in crisis or other similar hardship situations in the future.
Academic Support - Mentors

PI - Dr. Mónica Alfaro
Biology, Industrial Microbiology
Mentees: 7

Dr. Moises Orengo
Physics, Biotechnology, Math, Geology, PreMed, Nursing
Mentees: 8

Dr. M. Laura Cuevas
Chemistry, Agronomy, Biotechnology, Chemical Engineering
Mentees: 8

CoPI - Dr. Nayda Santiago
Computer, Mechanical & Electrical Engineering
Mentees: 7

Dr. Lourdes Medina
Industrial, Mechanical & Civil Engineering
Mentees: 6

Dr. Jose Fernando Vega
Electrical, Computer, Civil & Mechanical Engineering
Mentees: 6

Dr. Bernadette Delgado
Formative Evaluator

Socioemotional Support

Co-PI Dr. Canny Bellido
Socioemotional Support

Financial Support

Co-PI Prof. Mercedes Ferrer
Financial Support
GPA Range: 2.28-3.92 Average GPA: 2.98 GPA Mode: 2.95
From 30 Towns in PR

Total: 42 - 1st Sem 2018-19
40 - 2nd Sem

Male 24
Female 18

43%
57%
## EECOS Financial Support 2018-2019

<table>
<thead>
<tr>
<th>Semester 2018-19</th>
<th>Scholarships awarded</th>
<th>Financial support</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st semester</td>
<td>42</td>
<td>$105,000.00</td>
</tr>
<tr>
<td>2nd semester</td>
<td>40</td>
<td>$100,000.00</td>
</tr>
</tbody>
</table>

Total of $205,000 scholarships awarded
15 Professional development activities invited to participate Spring semester 2018-19.

Collaborations with other projects – MARC, E-Ship Network, RUMboEx, Biology Department, ePearls, CAHSI

2 individual meetings of the Academic Mentor with each scholar per semester.
Academic Support

• CiviCRM Platform
  • Open source database to register all interactions of mentor and mentee.
Socioemotional Support

**Screening Tests** (December 2018):

- Direct exposition to disaster
  - 100% high to severe.
- Beck Anxiety Inventory
  - 61% of scholars present high levels of anxiety

---

**Mindset**

- Growth: 30%
- Fixed: 14%
- Mixed: 56%

**REFERED TO PSYCHOLOGICAL SERVICES**

- Yes: 71%
- No: 29%
Estrategias para Auto-Cuidarnos y ser Resilientes

Este mes estaremos dedicando este espacio a estrategias para auto-cuidarnos y ser resilientes. Ser realistas y aprendiendo de nuestras experiencias, nos ayudará a superar las dificultades. Aprenderá a tomar decisiones que nos beneficien a largo plazo.

Te ofrecemos una serie de materiales de escritoría y en video con temas que van desde la alimentación adecuada, las costumbres del sueño hasta las técnicas de relajación. (Ver: https://www.consumers.org/tv)

No olvides la lista de videos para que descubras los que te interesen de acuerdo a tus necesidades.

¡Cuidate! Prof. Ganny Bellido

10 Alimentos beneficiosos para el cerebro
Cómo estudiar de forma efectiva [Flyer]
Una mejor manera de autodidacta
Estrategias de auto-cuido para ser más productivos [Videos]
Hoy gracias a Dios, a mi familia, a la gente de mi departamento, compañeros de diferentes clases en ese entonces, pero en especial al Programa EECOS puedo decir que lo logré. Logré vencer todas esas adversidades que en algún momento me hicieron pensar quitarme, pero no aquí estoy, fuerte y decidida cumpliendo con mi rol de madre, esposa y estudiante.

Finalmente y para dar por terminado me encuentro a ley de días para desfilar en la Centésima Sexta Colación de Grados de la mejor Universidad de Puerto Rico, Recinto de Mayagüez, mejor conocida como el Antes, Ahora y Siempre.... COLEGIO!!!

Muchas Gracias…

<table>
<thead>
<tr>
<th>20. Indicate knowledge, skills, and/or attitude change acquired as a result of the mentoring relationship.</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 responses</td>
</tr>
<tr>
<td>Better understanding of my opportunities to my future goals, how important is the emotional area in my life, how can I organize for the rest of my academic years, how to open up more and develop myself better as a professional.</td>
</tr>
<tr>
<td>Think outside the box, be more empath &amp; know that there's people with bigger problems than mine.</td>
</tr>
<tr>
<td>I now have a different approach when studying for my harder classes thanks to my mentor's advice.</td>
</tr>
<tr>
<td>I learned how to learn better and organize myself better.</td>
</tr>
<tr>
<td>Aprendi a organizar mi tiempo. Aunque sí me gustaría mejorarla.</td>
</tr>
<tr>
<td>Estoy estudiando más efectivamente gracias a ella, he aprendido a dejar de trancarme por mis errores, aprender de ellos y mejorar académicamente.</td>
</tr>
<tr>
<td>She helped me to organize and prepare plans to have a better result when dividing time and evaluating more effective times or profit to study.</td>
</tr>
<tr>
<td>Better organization</td>
</tr>
<tr>
<td>My attitude is more optimistic now that I have mentoring</td>
</tr>
<tr>
<td>Estoy más enfocado en seguir estudiando en estudios graduados.</td>
</tr>
</tbody>
</table>
Program Overview

Dr. Manuel Jimenez, PI

Co-Pis: Dr. Sonia Bartolomei, Dr. Marcelo Suárez, Dr. Aidsa Santiago
Senior Personnel: Dr. Nayda Santiago, Dr. Pedro Quintero, Dr. Carla López del Puerto, Dr. Nelson Cardona, Dr. Anidza Valentin
Evaluators: Dr. Luisa Guillemard, Dr. Janet Bonilla
Objectives and Vision

**Project Objectives**
- Increasing the retention and success of low-income, academically talented students (LIATS) in engineering
- Researching an intervention model based on social cognitive career theory and attrition mitigation, in a framework provided by a structured scholarship program

**Mission**
- Recruiting, Retaining, and Engaging Academically Talented Students from Economically Disadvantaged Groups into a Pathway to Successful Engineering Careers

**Vision**
- Providing guidelines to establish institutional policies and practices for improving LIATS success
College Access & Success Model

LIATS Background Experiences

Outcome Expectations

Self-efficacy Beliefs

Interest

Action

Graduation Goal & Performance Achievements

Belonging

Formation

Growth

Institutional Experiences & Interventions

LIAT College Access & Success Model
Student Distribution by Municipality

<table>
<thead>
<tr>
<th>City</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Sebastián</td>
<td>6</td>
</tr>
<tr>
<td>Ponce</td>
<td>5</td>
</tr>
<tr>
<td>Aguada</td>
<td>4</td>
</tr>
<tr>
<td>Utuado</td>
<td>4</td>
</tr>
<tr>
<td>Bayamón</td>
<td>3</td>
</tr>
<tr>
<td>Caguas</td>
<td>3</td>
</tr>
<tr>
<td>Camuy</td>
<td>3</td>
</tr>
<tr>
<td>Añasco</td>
<td>2</td>
</tr>
<tr>
<td>Carolina</td>
<td>2</td>
</tr>
<tr>
<td>Cayey</td>
<td>2</td>
</tr>
<tr>
<td>Cidra</td>
<td>2</td>
</tr>
<tr>
<td>Hatillo</td>
<td>2</td>
</tr>
<tr>
<td>Humacao</td>
<td>2</td>
</tr>
<tr>
<td>Moca</td>
<td>2</td>
</tr>
<tr>
<td>Quebradillas</td>
<td>2</td>
</tr>
<tr>
<td>Salinas</td>
<td>2</td>
</tr>
<tr>
<td>San Juan</td>
<td>2</td>
</tr>
<tr>
<td>Vega Baja</td>
<td>2</td>
</tr>
<tr>
<td>Yauco</td>
<td>2</td>
</tr>
<tr>
<td>Adjuntas</td>
<td>1</td>
</tr>
<tr>
<td>Aguas Buenas</td>
<td>1</td>
</tr>
<tr>
<td>Aibonito</td>
<td>1</td>
</tr>
<tr>
<td>Barranquitas</td>
<td>1</td>
</tr>
<tr>
<td>Cabo Rojo</td>
<td>1</td>
</tr>
<tr>
<td>Canóvanas</td>
<td>1</td>
</tr>
<tr>
<td>Ciales</td>
<td>1</td>
</tr>
</tbody>
</table>

Total: 92

26 Municipalities
Contact US

Web Site:  
[www.uprm.edu/engineering/pearls](http://www.uprm.edu/engineering/pearls)

Email:  
[engineering_pearls@uprm.edu](mailto:engineering_pearls@uprm.edu)

Office:  
Stefani Building 201  
Ask for Ms. Virginia Figueroa, ePEARLS Officer
Collaborative Research on Resilient Infrastructure and Sustainability Education - Undergraduate Program

HSI# 1832468; 1832427
Carla López del Puerto
Department of Civil Engineering and Surveying
PI: HSI# 1832468

Jose Luis Perdomo
School of Architecture
PI: HSI# 1832427

Jonathan Muñoz
Department of Civil Engineering and Surveying
Co-PI

O. Marcelo Suárez
Department of Material Science and Engineering
Co-PI

Drianfel Vázquez
Department of Engineering
Co-PI

Senior Personnel - Fabio Andrade, Ismael Pagán, Ricardo López, Luis Suárez

External Evaluator - Walter Díaz
Our purpose is to **educate** future environmental designers and engineering to **plan and build a more resilient and sustainable infrastructure for Puerto Rico**, through

- Interdisciplinary program in resilient infrastructure and sustainability
- Rapid response and resilience to counter natural disasters
- Novel curricular sequence
- Undergraduate research and internships opportunities
BROADER IMPACT

- To benefit society by increasing capacity of engineers, surveyors and environmental designers
- To work on issues related to resiliency and sustainability
- Development of a database of case studies available for research and modeling.
RISE-Up

Governments + Private Sector + Other Stakeholders

RIE PIEDRAS CAMPUS
- Environmental Design

MAYAGUEZ CAMPUS
- Civil Engineering
- Electrical Engineering
- Engineering Science and Materials
- Surveying

PONCE CAMPUS
- Construction

High Impact Collaborative Structure
All courses share a common goal of creating synergetic interactions among these four domains:

- Integrated Project Delivery
- User-centered design
- Problem-solving
- Sustainability and resiliency
### Courses

<table>
<thead>
<tr>
<th>Level</th>
<th>RISE-UP Courses</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fundamentals of Integrated Practice for Resilient and Sustainable Infrastructure*</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>RISE-UP Seminar Series</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Experiential Learning (Internship/ Undergraduate Research)</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Resilient and Sustainable Design and Construction *</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Design- Build Project Delivery *</td>
<td>3</td>
</tr>
</tbody>
</table>

* Proposed courses subject to change, approval pending.

Total Credits: 15

- Courses may be counted as free electives
- Levels 4 and 5 are advanced undergraduate (5000 level) courses which may be used as part of a graduate program at UPR.
Experiential Learning

- Targeted undergraduate research and internship opportunities
- Integration with the curricular development
- Enhanced retention and success among undergraduates
- Experiential learning to assess and ameliorate the vulnerability of the infrastructure
- Resiliency in logistics associated with infrastructure (from construction to reliable power and communications)
- The experiential learning component as an integral part of the environmental design, civil, electrical and materials engineering, construction, and complementary areas
- Training as a critical component of RISE-UP strategy
Database

RISE

Design variables

- Design variables 1
- Data collection
- Design variables 2

Case studies

- Infrastructure 1
  - Performance 1
- Infrastructure 2
  - Performance 2

Environmental variables

- Extreme event
Activities

- UPR Ponce students visiting the materials lab at the Civil Engineering building, UPR Mayagüez
- Understanding Earthquake Effects on Structures with Experimental Learning Utilizing a Shaking Table
- RISE-UP Program Poster Presented at the 2019 Emerging Researchers National (ERN) in STEM Conference
- HSI Conference, Mayagüez, PR
Contacts

UPR-Mayagüez
Dr. Carla López del Puerto
Carla.Lopezdelpuerto@upr.edu

UPR-Rio Piedras
Dr. Humberto Cavallín
humberto.cavallin1@upr.edu

UPR-Ponce
Dr. Drianfel Vázquez
drianfel.vazquez@upr.edu

Disclaimer
Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Acknowledgments
This material is based upon work supported by the National Science Foundation under grants No. HSI #1832468 and 1832427 (HSI program).

The research team acknowledges the collaboration with the CREST Phase II: Nanotechnology Center for Biomedical, Environmental and Sustainability Applications (#1345156), and the Civil Infrastructure Research Center. The contributions of Dr. Milagritos Gonzalez in developing the project’s evaluation plan and research assessment plan, and the contributions of the undergraduate and graduate students involved in the project.
Thank you!